ATTACHMENT D

GENERAL POPULATION EXPOSURE ASSESSMENT FOR N-PROPYL BROMIDE (NPB)

1. INTRODUCTION

N-propyl bromide (NPB) is used in various solvent, aerosol, and adhesive formulations as an alternative to ozone-depleting substances (ODS) such as methyl chloroform. However, in animal studies, NPB has been shown to exhibit toxicity to the liver and reproductive system following inhalation exposure. To date, the potential for significant exposure of the general populations living near facilities that use n-propyl bromide has not been adequately assessed. This document attempts to provide a brief assessment of these exposures.

This assessment focuses on the long-term general population exposure as a result of routine adhesive application. This end use was chosen because adhesive use is more emissive than either the solvents cleaning or the aerosol solvent end uses[1]. Thus, EPA expects that the greatest NPB exposure to the general population will result from adhesive operations.

2. APPROACH

A risk screening exposure assessment has been conducted with the objective of determining a reasonable foreseeable worst-case scenario for general population exposure associated with the use of n-propyl bromide. The exposure assessment uses a hypothetical adhesive application facility based on data collected from actual facilities (EPA 2001). The collected data have been used in this analysis to characterize the typical high-use adhesive application facility and an average-use adhesive application in an urban locale, assuming a row-house-type warehouse setting.

Two emission release scenarios were considered in the analysis:

1. Emissions released from the average-size adhesive application facility for the bonding of furniture and mattresses (S5); and

2. Emissions released from the urban row-house-type warehouse setting in which application of n-propyl bromide is used to bond furniture and mattresses (S6).

Please refer to the document entitled, "Occupational Exposure Assessment for NPB" for a description of the potential exposure setting in adhesives operations.

[1] In cleaning applications, use of vapor degreasers generally reduces emissions of NPB to very low levels in the ambient air. Although NPB used in aerosol solvents is an emissive use, aerosol solvents are typically used intermittently and in relatively small amounts. This is in contrast to adhesive applications where NPB is aerosolized to the ambient air in large amounts throughout a typical workday.

Average Size Adhesive Application Facility (S5)

The general characteristics used in the modeling of the average adhesive-application facility for the bonding of furniture and mattresses are:

- Average size facility: 65.7 meters x 65.7 meters;
- Average height of the facility: 7 meters;
- Typical lot size of 100 x 100 meters (~ 2.5 acres);
- Urban setting;
- Average high use adhesive emission rate of 12.3 g/s;
- Facility operates 2000 hours per year (40 hr/week, 50 weeks/year);
- Average breathing height of 1.8 meters; and
- For the vented scenario the facility operates a ventilation system at the ASHRAE recommended flow rate of 0.50 cubic feet per minute/ft^2 of floor space. (i.e., 1.3 air exchanges per hour) (ASHRAE 1999). The stack was located on the roof, a short 0.3-m stack with an inside diameter of 0.8-m was assumed. Estimates of concentration included the effects of building downwash within cavity region, for both the near- and far-wake regions.

Within S5, three types of releases were considered:

1. Emissions released as a fugitive (non-vented) area source released upwards through the roof of the facility;

2. Emissions released as a single point source (vented) upwards on the roof of the facility; and

3. Emissions released as a fugitive (non-vented) source horizontally through cracks, leaks, window ventilation and shaft ventilation (natural ventilation).

Urban Row-house-type Warehouse Adhesive Application Operation (S6)

The general characteristics used in the modeling of the urban row-house-type warehouse adhesive application operation are:

- Three-story (30 feet) house, with a footprint of 25 feet x 40 feet;
- Urban setting;
- Average high use adhesive emission rate of 1.23 g/s;
- Facility operates 50 weeks per year, 8 hours per day, 5 days per week;
- Average breathing height of 1.8 meters;
- Nearest resident is adjacent to the house at a distance of 3-m; and
- For the vented scenario the facility operates a ventilation system at the ASHRAE recommended flow rate of 0.50 cubic feet per minute/ft^2 of floor space (i.e., 1.3 air exchange per hour) (ASHRAE 1999). The stack was located on the roof with a short 0.3-m stack with an inside diameter of 0.8-m. Estimates of concentration included the affects of building downwash within cavity region, for both the near- and far-wake regions.

Within S6, four types of releases were considered:

1. Emissions released as a fugitive (non-vented) area source upwards through the roof of the warehouse;

2. Emissions released as a single point source (vented) upwards on the roof of the warehouse;

3. Emissions released as a fugitive (non-vented) source horizontally through cracks, leaks, window ventilation and shaft ventilation (natural ventilation); and

4. Emissions released as a fugitive source horizontally using commercially available fans capable of accomplishing at least 1.3 air exchanges per hour.

3. MODELING SYSTEM

EPA's SCREEN3 (EPA 1995) air dispersion model was used to assess dispersion of emissions using the full range of meteorological conditions (all stability classes and wind speeds) to estimate the highest 1-hour concentration. The SCREEN3 model is a "screening" model used to assess the likely maximum-potential concentration from a single source. The technique used here is typically used to evaluate air quality impacts of sources pursuant to the requirements of the Clean Air Act, such as prevention of significant deterioration (PSD), new source review, and existing sources of air pollutants, including air toxics. The approach applied here is the initial-phase approach used to determine if either (1) the source clearly poses no air quality problem or (2) the potential for an air quality problem exists. If a potential problem exists then a more refined analysis is necessary following approaches discussed in the Guideline on Air Quality Models (Revised) (40 CFR Parts 51 and 52). For a site-specific analysis using site-specific meteorological data the use of the long-term dispersion model, Industrial Source Complex Long Term (ISCLT) is preferred, but unfortunately this approach cannot be used in this analysis because the site-specific meteorological data are not available.

EPA's screening procedures (EPA 1992) for annual average concentration require that estimates be developed by multiplying the maximum 1-hour concentration determined by SCREEN3 by a factor of 0.10. The multiplying factors are based upon general experience with relationships between maximum short-term concentrations and annual average concentrations based on observations. The factors account for the fact that the meteorological conditions that produce the highest 1-hour concentrations do not occur throughout the year (i.e., variations in wind speed, direction, atmospheric stability). The factors are intended as a way to estimate the maximum annual concentrations from short-term averages, and a degree of conservatism is incorporated in the factors to provide reasonable assurance that maximum annual values will not be underestimated. The range of factors that may be used with this model is (0.06 to 0.10). Using a factor of 0.10 in this risk screen incorporates an additional degree of conservatism since this number represents a worst-case maximum annual average concentration assuming that aerodynamic downwash and/or low stack height is a problem for most adhesive application facilities.

The SCREEN3 model can provide estimated concentrations for distances less than 100 meters (down to one meter as in other regulatory models). However EPA/OAQPS recommends caution when using results at distances of less than 100 meters, as concentrations may be suspect. A recent model validation study (EPA 1998) for similar conditions (flat terrain, non-buoyant, near-surface release, measurements at arcs positioned 50 m to 800 m downwind) using the short-term Prairie Grass tracer study have shown that the

ISC3 model[2] predicts well within a factor of 2 for all downwind distances. According to the Prairie Grass study, Industrial Source Complex (ISC3) shows an overall tendency to over predict by an average of 50% for all downwind distances further supporting that the results from this screen results are conservatively based and fair estimates of the near source concentration of NPB.

The accuracy of the ISC3 and SCREEN3 type model estimates have been evaluated by comparison with observed concentrations in two studies (EPA 1982; EPRI 1983). The studies found that: (1) these types of models are more reliable for estimating longer time-averaged concentrations than for short-term concentrations; and (2) the models are reasonably reliable in estimating the magnitude of the highest concentrations occurring sometime, somewhere within an area. Errors in the highest estimated concentrations of 10 to 40 percent were found to be typical, and well within the factor of 2 accuracy recognized for these models noted in the Guideline on Air Quality Models (Revised) (40 CFR Parts 51 and 52).

4. RESULTS

Results from the two scenarios are presented in Table 1 and 2 with a comparison to the reference concentration (RfC) for NPB (See Attachment B)[3]. For the average sized high adhesive use facility (S5) the vented emission concentrations are lower than the non-vented emissions and are well below the RfC. These values include building downwash. The additional momentum from the ventilation system appears to be of sufficient magnitude to lower the concentrations over the non-vented scenario. None of the ventilation scenarios for S5 showed concentrations exceeding the RfC.
For urban row-house-type warehouse (S6), again none of the scenarios show an exceedance of the RfC, although it is worth noting that the non-vented horizontal release with fans case shows relatively high values compared to other S6 cases. The two vertical release scenarios show maximum concentrations occurring at a distance of 30 meters from the house due to the height and upward momentum associated with the release.

[2] The basic dispersion algorithms contained within the SCREEN3 are identical to ISC3 – the ISC3 model allows the user more flexibility in inputting meteorological data, multiple sources, and source locations.
[3] An RfC is an estimate of a continuous inhalation exposure to the general public (including sensitive subgroups) that is likely to be without an appreciable risk of adverse health effects during a lifetime.

TABLE 1. SCENARIO 5: MAXIMUM ANNUAL AVERAGE AIR CONCENTRATIONS IN THE VICINITY OF AN AVERAGE SIZED HIGH ADHESIVE APPLICATION FACILITY USING N-PROPYL BROMIDE (S5)

Distance	Non-Vented Vertical Release Scenario	Vented Vertical Release Scenario	Non-Vented Horizontal Release Scenario	Reference Concentration Level
(m)	(ppm)	(ppm)	(ppm)	(ppm)
100	0.06	0.01	0.08	1
200	0.04	0.01	0.04	1
300	0.03	0.01	0.03	1
400	0.01	0.01	0.01	1
500	0.01	0.01	0.01	1
600	0.01	0.01	0.00	1
700	0.00	0.00	0.00	1
800	0.00	0.00	0.00	1
900	0.00	0.00	0.00	1

TABLE 2. SCENARIO 6: MAXIMUM ANNUAL AVERAGE AIR CONCENTRATIONS IN THE VICINITY OF AN AVERAGE ADHESIVE USING OPERATION LOCATED IN AN URBAN ROW-HOUSE-TYPE WAREHOUSE USING N-PROPYL BROMIDE

Distance	Vented Vertical Release Scenario*	Non-Vented Vertical Release Scenario	Non-Vented Horizontal Release (natural vent) Scenario	Non-Vented Horizontal Release (w/fans) Scenario	Reference Concentration Level
(m)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
3	0.00	0.00	0.06	0.24	1
5	0.00	0.00	0.06	0.19	1
10	0.00	0.00	0.04	0.13	1
20	0.00	0.01	0.03	0.08	1
30	0.03	0.01	0.01	0.05	1
40	0.03	0.01	0.01	0.04	1
50	0.03	0.01	0.01	0.04	1
60	0.01	0.01	0.01	0.03	1
70	0.01	0.01	0.01	0.03	1
80	0.01	0.01	0.00	0.01	1
90	0.01	0.01	0.00	0.01	1
100	0.01	0.01	0.00	0.01	1

* Maximum cavity region annual average concentration of 0.02 ppm assuming half of all hours when facility is operating are conducive to downwash conditions

5. REFERENCES

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